

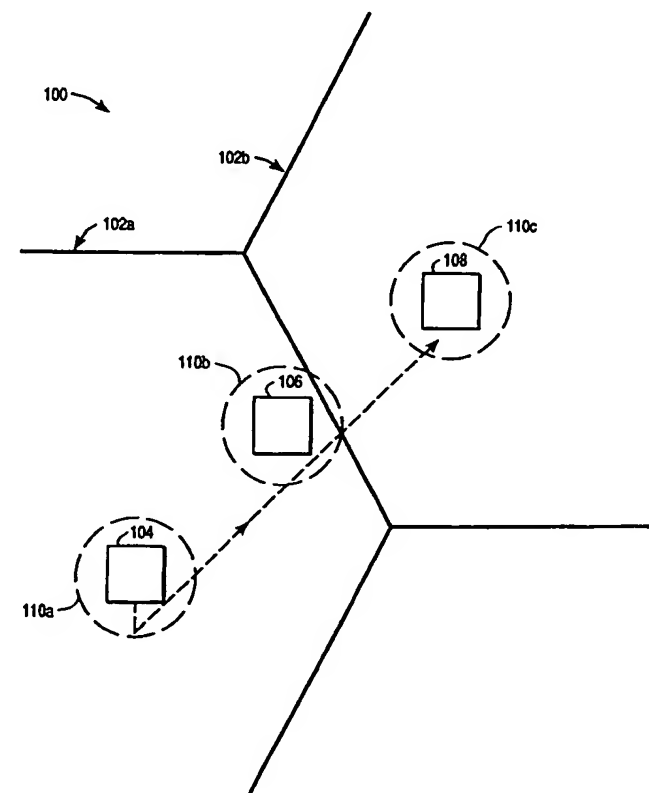


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/US97/23440 <b>(22) International Filing Date:</b> 17 December 1997 (17.12.97)  <b>(30) Priority Data:</b> 08/778,525                      3 January 1997 (03.01.97)                      US  <b>(71) Applicant:</b> SIEMENS BUSINESS COMMUNICATION SYSTEMS, INC. [US/US]; 4900 Old Ironside Drive, Santa Clara, CA 95052 (US).  <b>(72) Inventors:</b> SHAFFER, Shmuel; 1211 Cowper Street, Palo Alto, CA 94301 (US). BEYDA, William, Joseph; 21580 Edward Way, Cupertino, CA 95014 (US).  <b>(74) Agents:</b> VANCE, Heather, S. et al.; Siemens Corporation, Intellectual Property Dept., 186 Wood Avenue South, Iselin, NJ 08830 (US).		<b>(81) Designated States:</b> BR, CN, JP, KR, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>Without international search report and to be republished upon receipt of that report.</i>

**(54) Title:** SYSTEM AND METHOD FOR CELLULAR SMART SWITCHING**(57) Abstract**

A user's access patterns are accounted for in deciding to switch between a plurality of wireless networks (204, 206). A method according to one embodiment of the present invention includes monitoring a location of a wireless communication device (202) within a region serviced by a first wireless communication network (204) and second region serviced by a second wireless communication network (204). The first and second regions have an overlapping region which could be serviced by both networks. The future location of the wireless communication device (202) within the first and second regions is predicted based on the monitoring of the previous locations of the wireless communication device (202). When the wireless communication device (202) is detected as being within the overlapping region, the system determines whether to transfer an active connection between the wireless communication device (202) and one of the networks to the other network. In one embodiment, past patterns of usage of the wireless communication (202) device within the first and second region are identified and used to predict a future location based on the past pattern. In another embodiment, a calender of predetermined time-location associations is input into a controller (203) associated with the wireless communication device (202) and the prediction is based on an actual location and current time being compared with the values input into the calender.



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## **SYSTEM AND METHOD FOR CELLULAR SMART SWITCHING**

### **5 FIELD OF THE INVENTION**

The present invention relates to wireless communication systems and, more particularly, to an improved system and method for controlling hand-offs of calls from one wireless network to another.

### **10 DESCRIPTION OF THE RELATED ART**

During a call connecting a wireless communication device, such as a cellular telephone, with another telephone, the wireless communication device may cross from the domain of one wireless network to an independent wireless network. Such networks may comprise a company's private cellular telephone network and the  
15 public cellular telephone network, for example. Thus, to complete the call, the wireless communication device must be capable of being used in both the company's internal wireless system and in the public system, and accommodation must be made for controlling hand-offs from one network to the other.

Hand-off of a telephone call from the domain of the first wireless network to  
20 the domain of the second wireless network may be made via a control link shared between central processing units of the two networks. Using the control link, the two wireless networks are able to negotiate feasibility and operations of hand-off as described, for example, in EIA/TIA interim standard IS-42.2-B, "Cellular Radio Telecommunications Intersystem Operations: Intersystem Hand-Off," which is hereby  
25 incorporated by reference. While, ideally, hand-offs from one network to another are imperceptible to the user, in practice, hand-offs frequently introduce extraneous clicks and temporary loss of signal.

Frequently a user of the wireless communication device is required to travel from one company site to one or more other company sites, which can cause the  
30 wireless communication device to repeatedly switch back and forth between the

public and private systems. This can cause unnecessary hand-offs, particularly since typical systems assume that a private wireless system, free of call charges, is preferable to a public system, even though the public systems typically charge a per call access fee. In such systems, a hand-off is always made to the private system,  
5 whether or not it is the most efficient in terms of cost or signal quality.

This situation is illustrated more clearly with regard to Figure 1. In Figure 1, an exemplary two-network wireless communication system 100 is shown. A private company wireless system is installed in buildings 104, 106 and 108. As illustrated, each building 104, 106, 108 is associated with its own cell or service area 110a, 110b,  
10 and 110c, respectively. Overlapping the private wireless system is a public wireless system 102 having multiple cells, only two of which, 102a and 102b, are shown.

As illustrated by the dashed line in Figure 1, a user can travel from building 104 to building 108, crossing through cell areas 110a, 102a, 110b, 102b and 110c. Assuming that the user begins executing a telephone call in building 104, the user's  
15 call will be serviced by the private wireless network so long as he is within region 110a. As soon as the user leaves region 110a, he will be transferred to the public wireless carrier (so long as he is in region 102a). As the user approaches the vicinity of building 106, he will re-enter into the service area of the private wireless network as represented by cell 110b. His call will then be transferred back to the private  
20 network. As soon as the user leaves the area surrounding building 106, his call will be transferred from the private network to the public wireless network as he enters region 102b. Finally, as he approaches building 108, his call will be transferred back to the private network as enters region 110c.

By the time the user gets to building 108, he has been transferred four times,  
25 each time with a momentary loss of conversation, a change in signal quality and, with every transfer to the public wireless carrier, a new charge per call. Accordingly, a system and apparatus is desired which minimizes the number of unnecessary hand-offs between private and public wireless networks so as to minimize charges and enhance the quality of the call.

**SUMMARY OF THE INVENTION**

The above described problems are overcome in large part by a system and method according to the present invention in which a user's access patterns are accounted for in deciding to switch between the private and public wireless networks.

- 5 A system and method according to one embodiment of the present invention includes monitoring a location of a wireless communication device within a plurality of regions serviced by a plurality of wireless systems, e.g., a first region serviced by a first wireless communication system and a second region serviced by a second wireless communication system. The first and second regions have an overlapping
- 10 region which could be serviced by both networks. The system predicts the future location of the wireless communication device within the first and second regions based on the monitoring of the previous locations of the wireless communication device. When the wireless communication device is detected as being within the overlapping region, the system determines whether to transfer an active connection
- 15 between the wireless communication device and one of the networks to the other network based on the monitoring information.

- In one embodiment, past patterns of usage of the wireless communication device within the first and second regions are identified and used to predict a future location based on the past pattern. In another embodiment, a calendar of
- 20 predetermined time-location associations is input into a controller associated with the wireless communication device, and the prediction is based on an actual location and current time being compared with the values input into the calendar.

- A method according to another embodiment of the invention comprises compiling a database of time-location associations of a wireless communication
- 25 device within a first region serviced by a first wireless communication system and a second region serviced by a second wireless communication system. The first region and second regions have a predetermined overlapping region. The method further comprises detecting when the wireless communication device is present within the overlapping region during an active connection and predicting a future location of the
- 30 wireless communication device within the first region or the second region during the

active connection. Finally, the method comprises determining whether to transfer the active connection between the wireless communication device and the first or second wireless communication systems to the other when the wireless communication device is detected as being within the overlapping region.

5           A wireless telecommunication system according to an embodiment of the present invention comprises a first wireless network providing service over a first predetermined region and comprising a first switching office, and a second wireless telephone network providing service over a second predetermined region and comprising a second switching office. The first predetermined region and the second  
10   predetermined region overlap in a third predetermined region. A wireless communication device is configured for use in both networks. The second switching office comprises a memory unit configured to store a database of time-location associations related to a presence of the communication device in either the first predetermined region or the second predetermined region. The second switching  
15   office also includes a wireless switching control unit coupled to the database, and configured to access the database when the communication device is detected within the third predetermined region and to transfer an active call between the networks based on the time-location associations.

## 20   BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention is obtained when the following detailed description is considered in conjunction with the following drawings in which:

Figure 1 is a diagram illustrating an exemplary two network wireless system  
25   and the movement of a user therein;

Figure 2 is a block diagram of a wireless network system according to an embodiment of the present invention;

Figure 3 is a more detailed block diagram of a wireless communication device and interface between two wireless networks according to an embodiment of the  
30   present invention;

Figure 4 is a flowchart illustrating monitoring of time and location usage patterns; and

Figures 5-7 are flowcharts illustrating operation of various embodiments of the present invention.

5

## **DETAILED DESCRIPTION OF THE INVENTION**

### **Figure 2 -- Wireless Network System**

Turning now to Figure 2, a diagram illustrating the interaction of a wireless communication device 202, a stationary telephone 207, and two wireless systems 204, 206 is illustrated. The system and method of the present invention can be used to facilitate the interaction of one or more wireless communication devices 202 and a plurality of wireless systems or networks. In Figures 1-7, the present invention is described with reference to private wireless network 204 and public wireless network 206. As used herein, "wireless communication device" refers to any wireless communication device or wireless telephone, including, for example, pagers, cellular telephones, PCS devices, and other wireless messaging, voice, and data communication devices.

The system 200 includes a private wireless network 204 and a public wireless network 206. Wireless networks 204 and 206 are exemplary of cellular communication device networks or PCS networks of various types. Private wireless network 204 includes a wireless private branch exchange 210 which provides central switching functions to a plurality of cells 210a, 210b, and 210c. Each cell 210a, 210b, and 210c includes an antenna for receiving signals from a wireless communication device and associated equipment, referred to as a base station (not shown), for transmitting the received signals to the wireless private branch exchange 210. Wireless private branch exchange 210, in turn, is coupled to a central office 205 representative of, for example, a central office for coupling calls to the public switched telephone network. Wireless private branch exchange 210 further includes a wireless switching control unit 222 configured to record use patterns and store a database relating thereto according to the present invention. Wireless switching control unit 222 includes a processing unit and a memory device to facilitate these

functions, as will be described in greater detail below.

Public wireless network 206 includes one or more wireless communication device switching offices 208 (MTSO), or PCS switching offices, which provide switching functions to a plurality of cells 212a and 212b. Each MTSO 208 includes a communications controller 209 for supervising communications within and external to the network. Again, each cell 212a, 212b includes a base station having an antenna for receiving signals from wireless communication devices and associated equipment for transmitting the signals to the MTSO 208. MTSO 208 is coupled to central office 205 (which may be a different central office than the one to which the private wireless network 204 is coupled).

Wireless communication device 202 is configured for use in either the private wireless network 204 or the public wireless network 206. Wireless communication device 202 may thus be configured to receive, transmit and process signals according to various frequencies and/or coding standards and/or modulation formats of the varying public and private wireless networks. Exemplary protocols include time division multiple access (TDMA) and code division multiple access (CDMA) protocols. Wireless communication device 202 may also include a smart switching controller 203 configured to perform control operations relating to switching call connections on wireless communication device 202 between private wireless network 204 or public wireless network 206, as will be discussed in greater detail below.

To make a call, the wireless communication device must be registered as a user in the respective network. This is accomplished, for instance, by the communication device and the wireless private branch exchange exchanging control signals. Once the registration occurs, a call from wireless communication device 202 within private wireless network 204 is transmitted to an antenna (not shown) in a cell 210a, 210b, 210c and from the antenna to the wireless private branch exchange 210. A connection is then made from the wireless private branch exchange 210 to either another wireless private branch exchange or to the central office 205. From the central office 205, the connection is made to the public switched telephone network.

Similarly, prior to making a call on public cellular network 206, an exchange



of control signals is performed between the wireless communication device 202 and an MTSO 208 of the network. Once this occurs, calls via the public cellular network 206 are made from wireless communication device 202 to an antenna (not shown), within the respective cell, which transmits the signal to the MTSO 208. The MTSO 5 208 in turn provides the connection to the central office 205 which connects to the public switched telephone network.

As will be discussed in greater detail below, wireless switching control unit 222 is configured to supervise the switching of calls between the two networks based on time-location associations.

10

### Figure 3 -- Block Diagram

Turning now to Figure 3, a more detailed block diagram of the wireless systems illustrating various components of one embodiment of the present invention is shown. Components which are common to Figure 2 retain the same reference 15 numerals.

Figure 3A illustrates wireless communication device 202. Wireless communication device 202 may include a smart switching control unit (SSC) 203 configured to supervise (in conjunction with the relevant switching exchanges) transfers of active telephone calls from one network to another, based on time-location 20 associations, as will be discussed in greater detail below. Smart switching control unit 203 may comprise a variety of circuits, including microprocessor or micro controllers, or application specific integrated circuits (ASIC).

Wireless communication device 202 further includes a wireless private branch exchange communications module (WPCM) 252, a connection transfer module 25 (CTM) 254, a PCS communications module (PCM) 256, and an RF signal strength indicator module 213 (RSSI).

Each of the various modules may be comprised in microprocessor or micro controller chips, or in application specific integrated circuits (ASICs). WPCM 252 is used to supervise communications between the telephone 202 and the wireless private branch 30 exchange 210. PCM 256 is similarly used to supervise communications between the

wireless communication device 202 and the MTSO or PCS switch 208. CTM 254 supervises the switching of calls between cells within a particular network, and between the networks, as will be described in greater detail below. RSSI 213 is used for recognizing the need to make a transfer of a call from, for example, WPBX 210  
5 because of signal fade, which occurs when the caller has gone past a boundary of the region serviced by the private wireless network 204.

Turning now to Figure 3B, wireless private branch exchange 210 is illustrated. Wireless private branch exchange 210 includes a call management module (CMM) 223, an RF communications module (RFCM) 225, and a wireless switching control  
10 unit (WSC) 222. CMM 223 is used for managing the various telephony functions or services associated with the call, such as call transfer, conference call, and the like. RFCM 225 includes an RF transceiver (not shown) and supervises the registration and call set-up of the wireless communication device, as well as the handover or hand-off from one cell to another, and to other networks. WSC 222 is used to supervise the  
15 inter-network switching management functions based on time-location associations according to the present invention. More particularly, WSC 222 includes a processor or other control unit 231 and a memory 233 for storing a database of information which is used to predict a user's patterns of usage. In one embodiment, the database comprises a record of past usages monitored by the processor 231 of the WSC 222.  
20 In another embodiment, the database comprises a user-input calendar of future time-location associations. The processor 231 aboard WSC 222 further monitors the location of the wireless communication device 202 when a call is made or received. The processor 231 accesses the database 233 and predicts a future location of the wireless communication device 202 to determine whether to switch from one network  
25 to another. It is noted that, while illustrated as a discrete unit, WSC 222 can be comprised within RFCM, or as a unit external to the WPBX 210. Thus, Figure 3 is exemplary only. In addition, it is noted that, while the system preferably operates according to software, hardware implementations are contemplated.

A description of the operation of the RSSI 213 is deemed appropriate. When  
30 the wireless communication device's RSSI 213 detects that signal strength has fallen

below a predetermined threshold, RSSI 213 communicates with the WPCM 252 to cause the WPCM 252 to attempt to make a handover to another antenna (i.e., within an adjacent cell) having a suitably strong signal. If the WPCM 252 cannot make a handover to an antenna within the private wireless network 204, it sends a signal to  
5 CTM 254. In response, CTM 254 transmits a signal to PCM 256 to attempt to find another system to which it can transfer the connection.

PCM 256 includes controls and apparatus for registering the wireless communication device as a valid user of the public wireless network 206.

“Registration” refers to a method of verifying that the wireless communication device  
10 handset can communicate with a wireless network. This is accomplished with respect to public wireless network 206 by the wireless communication device 202 exchanging radio signals with the public wireless network 206 which are designed to establish status as a valid user. The exchange of radio signals takes place in accordance with protocols which are well known to those of skill in the art, for example, according to  
15 EIA/TIA interim standard “IS-54B Cellular System Dual Mode Mobile Station - Base Station Compatibility Standard.” If the registration is successful, PCM 256 sends a signal indicating that condition to CTM 254. CTM 254 in turn provides the connection (i.e., transfers the call between the networks).

According to the present invention, call transfers are made based on the time-  
20 location associations independent of the signal strength determination. Call transfers based on the time-location associations are similar to call transfers based on the signal strength determination. When the wireless communication device 202 enters within range of both networks, and a call is in progress, the processor 231 of the WSC 222 identifies whether the user will be repeatedly entering and exiting the region serviced  
25 by, for example, the private wireless network. This identification occurs through the processor 231 of the WSC 222 accessing a database in memory 233 in which user time-location associations are stored. In one embodiment, the time-location associations comprise a record based on the processor 231 monitoring the past usage of the wireless communication device 202. The locations can comprise, for example,  
30 the individual cells of the network. Time associations can be either based on duration

within the cell and time-of-day associations, where applicable. In another embodiment, the database time-location associations comprise a calendar manually input by the user of his or her predicted schedule. In still another embodiment, the database comprises a combination of a user-input calendar and the monitored record.

5 Assume, for example, that a call is in progress on the public cellular network 206, and the user enters a region serviced by the private network 204. The WPBX 222 learns of the presence of the wireless communication device, for example, via a signal from the wireless communication device 202, i.e., from the exchange of control signals described above. If, after accessing the database in memory 233, the  
10 processor 231 of WSC 222 determines that the user will not, in fact, be repeatedly entering and exiting the region serviced by the private network, the WSC 222 signals the SSC 203 of the wireless communication device 202. The wireless communication device 202 allows the CTM 254 to effectuate a transfer from the public wireless network to the private wireless network. The PCM 256 informs the MTSO 208 of  
15 the public network 206 to release the call, and it is switched to the private network 204. It is noted that while supervision of this functionality on the wireless communication device end has been described with regard to the SSC 203, this functionality may be incorporated into the various other modules of the wireless communication device. It is similarly noted that while RSSI 213 and SSC 203 are  
20 illustrated as discrete units, in alternative embodiments, they may be integrated into a single unit.

If the processor 231 of the WSC 222 determines that the user will be repeatedly entering and exiting the region serviced by the private network, the WSC 222 either does nothing, or provides a control signal indicating that the wireless  
25 communication device is to continue being serviced by the public wireless network.

In another embodiment, the time-location associations comprise a record of cells and transit patterns relating to durations of time required to cross through the cells. The stored transit patterns may result from monitoring past usages, as described above, or a calendar input by the user, again, as described above. Thus, if a user has  
30 an active connection in the public network, and enters and remains within a cell of the

private network for longer than a predetermined period, the system will switch to the private network. If the user stays within the cell for less than the predetermined period, however, the connection will remain with the public network.

For example, if the user has an active connection on the public network, his or  
5 her entry into a cell serviced by the private network will be detected, such as by the above-described registration process. The processor 231 accesses the database of time-location associations, which include a record of how long it takes to transit through the cell. If the user remains within the cell for longer than the determined period, the call connection will be transferred, as described above.

10

Figure 4 - Flowchart of One Embodiment of Processor Monitoring

Turning now to Figure 4, a flowchart illustrating the monitoring operation according to one embodiment of the invention is shown. Initially, a call involving wireless communication device 202 is detected (Step 450) and processed, for  
15 example, by the wireless private branch exchange 210. The call may be either a received call or one initiated by the wireless communication device 202. As discussed above, call processing includes the exchange of various control signals between the telephone's WPCM 252 and the wireless private branch exchange's CMM 223 and RFCM 225.

20 The processor 231 detects the servicing of the call and determines the time of the call (Step 452). In addition, the processor 231 determines the location of the wireless communication device 202 (Step 454) at the time of servicing the call. This may comprise, for example, the processor 231 monitoring present cell location and cell switching operations as controlled from the wireless private branch exchange.  
25 Alternatively, SSC 203 may provide control time-location information directly to the wireless private branch exchange. The processor 231 then stores the times and locations in memory 233, and later compiles it into a usable database (Step 456). It is noted that, in one embodiment, the monitoring of the wireless communication device's (and hence user's) location, may be disabled. It is similarly noted that, in an  
30 alternate embodiment, constant monitoring of the wireless communication device's

location (even when there is no active call), for example, by the SSC 203 (or other functional modules of the wireless communication device) registering within each cell, or providing information within a global positioning system (GPS), is contemplated. Finally, the monitoring of the usage patterns may further comprise  
5 monitoring the duration of time the user spends within a cell.

Figure 5 -- Flowchart of Operation of One Embodiment of the Present Invention

Turning now to Figure 5, a flowchart illustrating operation of an embodiment of the present invention is shown. Time-location associations of the wireless  
10 communication device are stored and compiled by the processor 231 as a database in the memory device 233 coupled to or within WSC 222 (step 302). For example, the location of the wireless communication device within the public network or the private network may be monitored by the processor 231 over time. The usage patterns of the wireless communication device (i.e., whether the wireless  
15 communication device is activated and registered as a user in a particular cell of one or the other of the networks) are monitored. Alternatively, and to provide a more accurate record of the user's actual schedule, so long as the wireless communication device is ON, the SSC 203 may be configured to provide a signal to the WSC 222 identifying the user's location within particular cells. The usage patterns may further  
20 comprise a record of the user's duration of time within a particular cell (i.e., how long it takes the user to transit through a cell).

Next, when the user initiates an active connection on the wireless communication device, the system detects the location of the device making the call (step 304). In addition to being used to manage the call, this information is used in  
25 order to determine whether the device's presence within a region serviced by the private network or the public network is transitory (i.e., whether the user will be repeatedly entering and re-entering one or the other of the networks). The processor 231 in the WSC 222 accesses its database and predicts what the user's usage is likely to be (Step 306). As noted above, this may comprise determining how long it should  
30 take for the user to transit through the particular cell.

Based on the present time and user location, and the result of the accessed time-location associations from the database, the processor 231 determines whether to transfer the call (Step 308). This may comprise, for example, the processor 231 waiting a predetermined period for the user to transit a cell. Finally, if the processor  
5 231 determines that a transfer is necessary, the appropriate control signals are issued which effectuate the transfer from the one network to another (Step 310). For example, if the call is presently being serviced by the public network, and a determination is made to transfer the call, the WSC 222 sends a signal to the WPCM 252 (for example), which in turn, signals the CTM 254 to initiate a transfer from the  
10 public network 206.

It is noted that the system preferably continually updates the database. Thus, a user's usage patterns that are inconsistent with the previously stored and compiled database record are periodically incorporated into an updated database, to more optimally predict a future location.

15

#### Figure 6 - Flowchart of Alternate Embodiment

Turning now to Figure 6, a flowchart illustrating operation of an alternate embodiment of the present invention is shown. In the illustrated embodiment, rather than monitoring past usage patterns, the system allows the user to input his schedule,  
20 according to time and location (Step 350). This may further comprise the user entering estimates of his or her transit times through particular cells. Thus, the user determines what his schedule is likely to be during, for example, the coming week. He or she then records this information, for example, on a computer diskette, and uploads the information to the WPBX 210. Alternatively, provision may be made for  
25 the user to input this information directly from the wireless communication device 202. The WSC 222 stores the information within the memory 233 and compiles a database.

Once the database has been compiled, the system is ready for use. Next, when the user initiates an active connection on the wireless communication device,  
30 the system (preferably processor 231) detects the location of the device making the

call (step 352). In addition to being used to manage the call, this information is used in order to determine whether the device's presence within a region serviced by the private network or the public network is transitory (i.e., whether the user will be repeatedly entering and re-entering a region serviced by one or the other of the networks). The processor 231 of WSC 222 accesses its memory 233 for the database (Step 354) and determines whether to transfer the call, by predicting what the user's future usage pattern is likely to be (Step 356). This may comprise waiting a predetermined period for the user to exit the cell. Finally, depending upon the outcome of the determination in Step 356, the call is transferred (Step 356).

For example, if the call is presently being serviced by the public network, and a determination is made to transfer the call, the WSC 222 sends a signal to the WPCM 252 (for example), which in turn, signals the CTM 254 to initiate a transfer from the public network 206. It is noted that the calendar operation described with regard to this embodiment may also be incorporated into the embodiment described above with respect to Figure 5. Thus, for example, both the user's schedule and his actual access patterns may be used to determine whether a call should be transferred from one network to the other.

Figure 7 -- Flowchart of Exemplary Operation of Present Invention

Turning now to Figure 7, a flowchart 400 illustrating an exemplary operation of the present invention is shown. Flowchart 400 illustrates the call processing procedure for a user traveling as illustrated in Figure 1. For example, the user initiates a call within building 104 serviced by cell 110a of the private wireless network 204. The call is routed to the wireless private branch exchange 210 connected to a central office 205 of the public switched telephone network (step 402). As illustrated by the dashed line, the user exits building 104 and leaves the area 110a serviced by the private wireless network 204 (step 404). The RSSI 213 detects a signal fade and requests a transfer to the public wireless network 206. The connection to the public network is executed as described above (step 406). The user continues on and enters cell 110b (near building 106), which is serviced by both the public network 206 and



the private network 204. Upon the user's entry into the area 110b, the system determines whether or not the user's presence within the area 110b is relatively permanent (i.e., whether the user is likely to be remaining within the building for longer than a predetermined period) (step 410). As described above, this  
5 determination is based on the WSC 222 accessing its database and providing appropriate controls signals responsive thereto.

If the user's presence is only transitory, the system will continue the call via the MTSO of the public network (step 412). If the user's presence within area 110b is determined to be relatively permanent, however, the call will be transferred to the  
10 private network to be serviced through the wireless private branch exchange 210 (step 416). If the user then leaves building 106 and enters the area serviced by cell 102b of the public network (step 418), the call will be transferred to the MTSO 208 of the public network (step 422).

If, in step 412, the user continues into cell 102b, serviced by the public  
15 wireless network (step 420), the call continues to be serviced by the public network (step 424). The user in either case continues on into area 110c, serviced by the private wireless network (step 426). Again, a determination is made whether or not the user's presence is relatively permanent or transitory (step 428). If the user's presence is determined to be only transitory (i.e., less than a predetermined period), then the call  
20 continues to be processed by the public wireless network (step 430). If, however, the user's presence is determined to be relatively permanent, then the call is processed by the private network (step 432).

The invention described in the above detailed description is not intended to be limited to the specific form set forth herein, but on the contrary, it is intended to cover  
25 such alternatives, modifications, and equivalents as can reasonably be included within the spirit and scope of the appended claims. For example, while illustrated with respect to a private wireless network and a public wireless network, the invention is equally applicable to more than one public network.

**CLAIMS**

We claim:

1           1.       A system for controlling the hand-off of a wireless communication  
2 device (202) between a first wireless communication network (204) and a second  
3 wireless communication network (206), characterized by:

4               means (233) for compiling a database of time-location associations of said  
5 wireless communication device (202) within a first region (272) serviced by said first  
6 wireless communication network (204) and a second region (274) serviced by said  
7 second wireless communication network (206), wherein said first region (272) and  
8 said second region (274) have a predetermined overlapping region (270);

9               means (231) for detecting when said wireless communication device (202) is  
10 located within said predetermined overlapping region (270) during an active  
11 connection;

12               means (231) for predicting a future location of said wireless communication  
13 (202) within said first region (272) or said second region (274) during said active  
14 connection, wherein said predicting means uses said database of time-location  
15 associations; and

16               means (222, 254) for transferring, based on a result of said predicting, said  
17 active connection between said one of said first or second wireless communication  
18 networks (204, 206) to the other of said first or second wireless communication  
19 networks (204, 206) when said wireless communication device (202) is detected as  
20 being within said predetermined overlapping region (270).

1           2.       The system of Claim 1, further comprising means (222) for monitoring  
2 past patterns of usage of said wireless communication device (202) in said first region  
3 (272) or said second region (274).

1           3.     The system of Claim 2, wherein said monitoring means (222)  
2     comprises means (231) for detecting an active connection between said wireless  
3     communication device (202) and a switching office (210, 208) of one of said first  
4     (204) and second wireless communication networks (206).

1           4.     The system of Claim 3, wherein said monitoring means (222) further  
2     comprises means (231) for determining a time of a making of said active connection.

1           5.     The system of Claim 4, wherein said monitoring means (222)  
2     comprises means (231) for determining a location of said wireless communication  
3     device during said making of said active connection.

1           6.     The system of Claim 2, wherein said compiling means (233) comprises  
2     means for storing records of said past patterns of usage in said database as said time-  
3     location associations.

1           7.     The system of Claim 1, further comprising means (231, 233) for  
2     storing a calendar of predetermined time-location associations of said wireless  
3     communication device (202) in said first region (272) or said second region (274)  
4     prior to compiling said database.

1           8.     The system of Claim 6, further comprising means (231, 233) for  
2     storing a calendar of predetermined times and locations of said wireless  
3     communication device (202) in said first region (272) or said second region (274)  
4     prior to compiling said database.

1           9.     The system of Claim 7, wherein said predicting means (231) comprises  
2     means (231) for comparing an actual location and current time with said time-location  
3     associations.

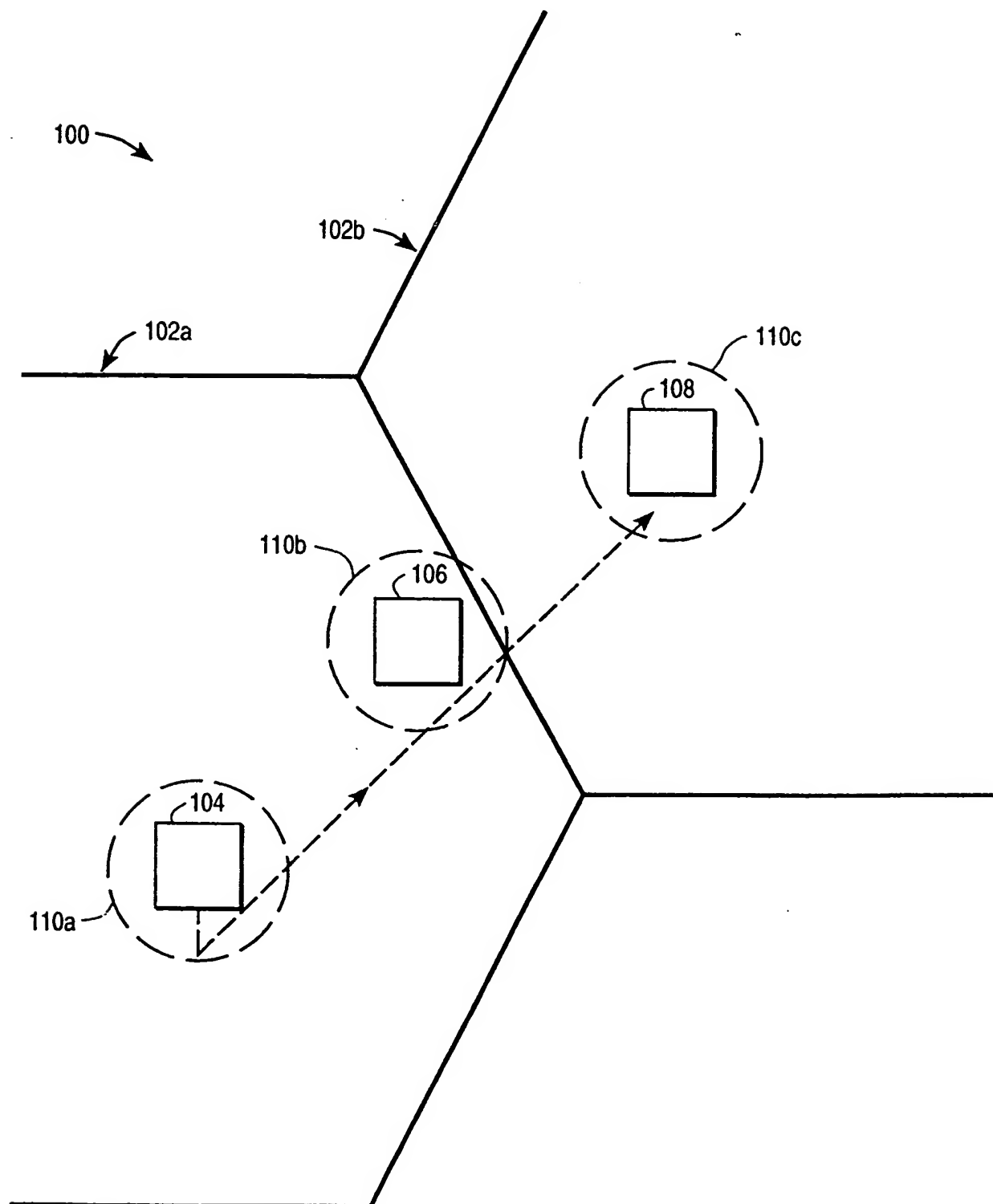
1           10.    The system of Claim 1, wherein said predicting means (231) comprises  
2     means (231) for comparing an actual location and time with said time-location

1        associations stored in said database.

1                11.     The system of Claim 1, wherein said predicting means (231) comprises  
2        means for determining whether said wireless communication device (202) is likely to  
3        repeatedly be in transit between said first region (272) and said second region (274).

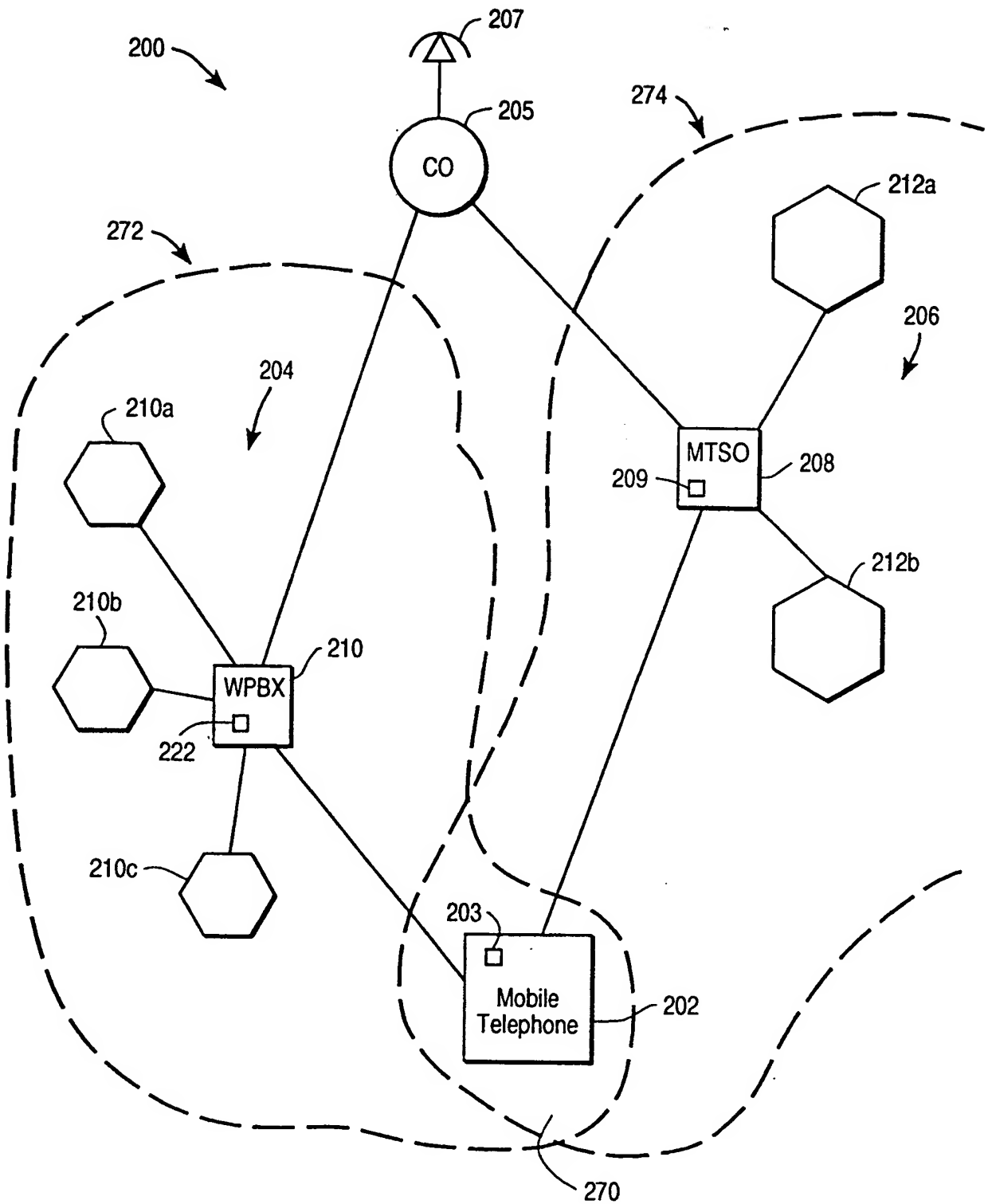
1                12.     The system of Claim 11, wherein said transferring means (222, 254)  
2        comprises means for transferring said active connection responsive to determining  
3        that said wireless communication device (202) is not likely to repeatedly be in transit  
4        between said first region (272) and said second region (274).

1 / 8

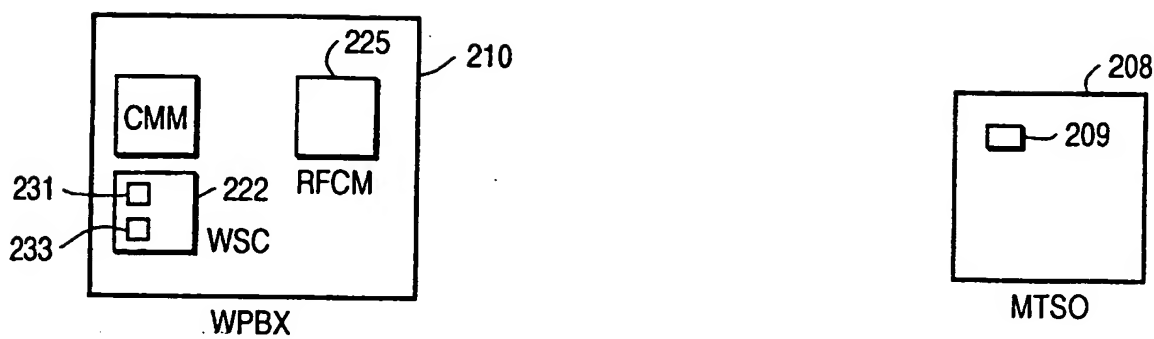


**FIG. 1**

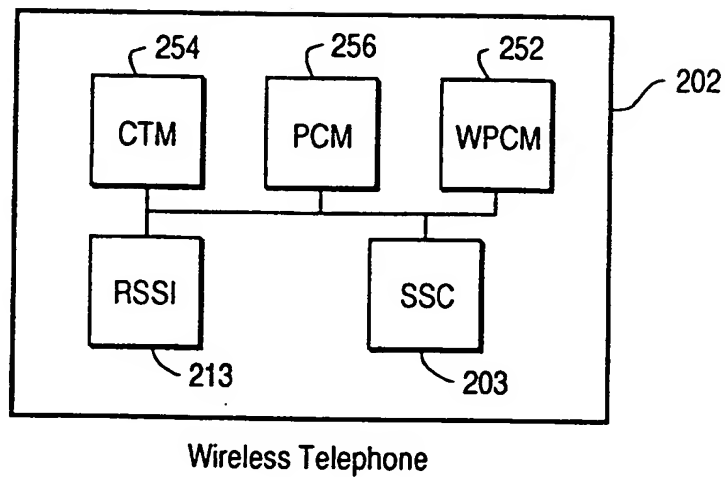
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**FIG 2**

3/8



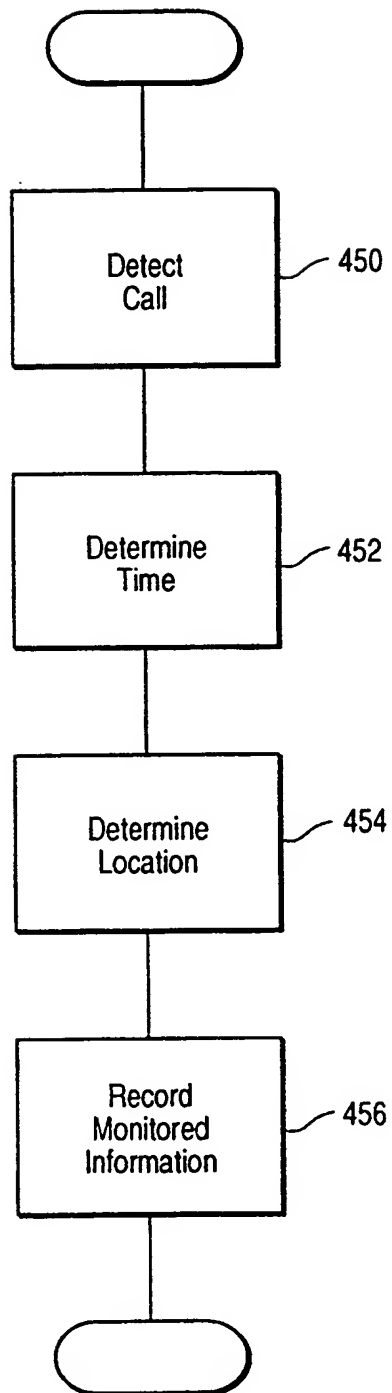
**FIG 3B**



**FIG 3A**

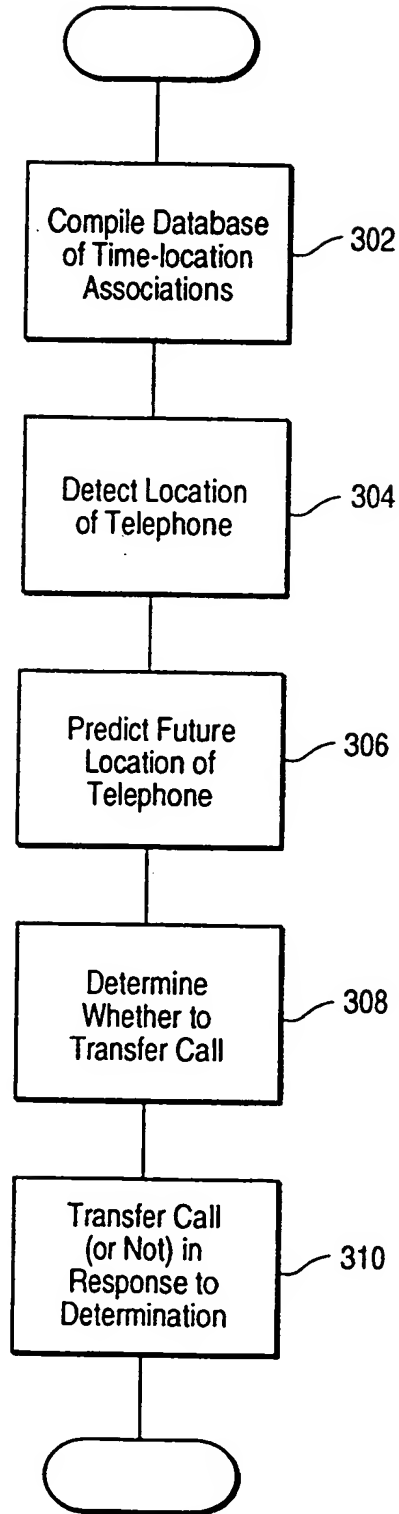
**FIG 3**

4 / 8

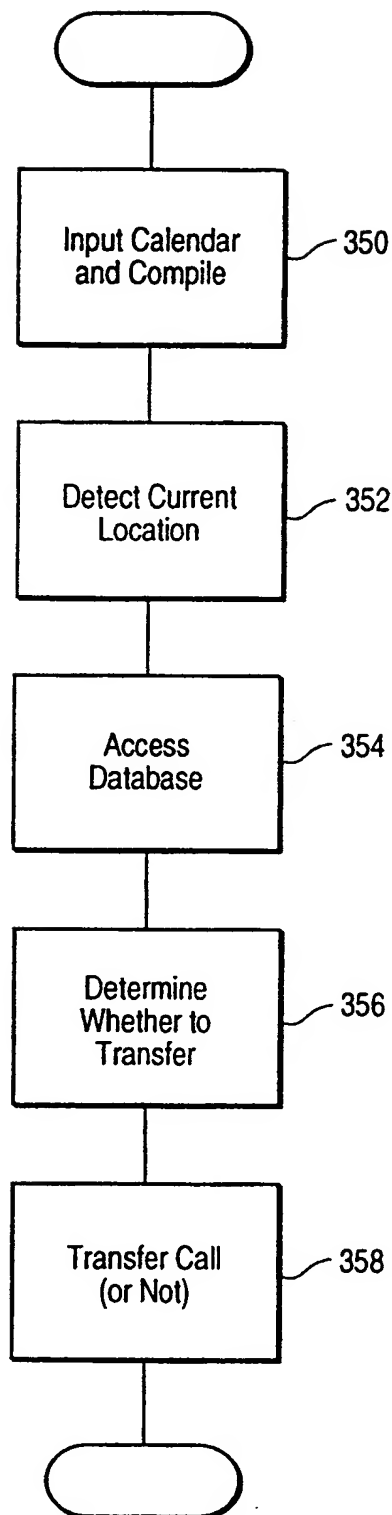




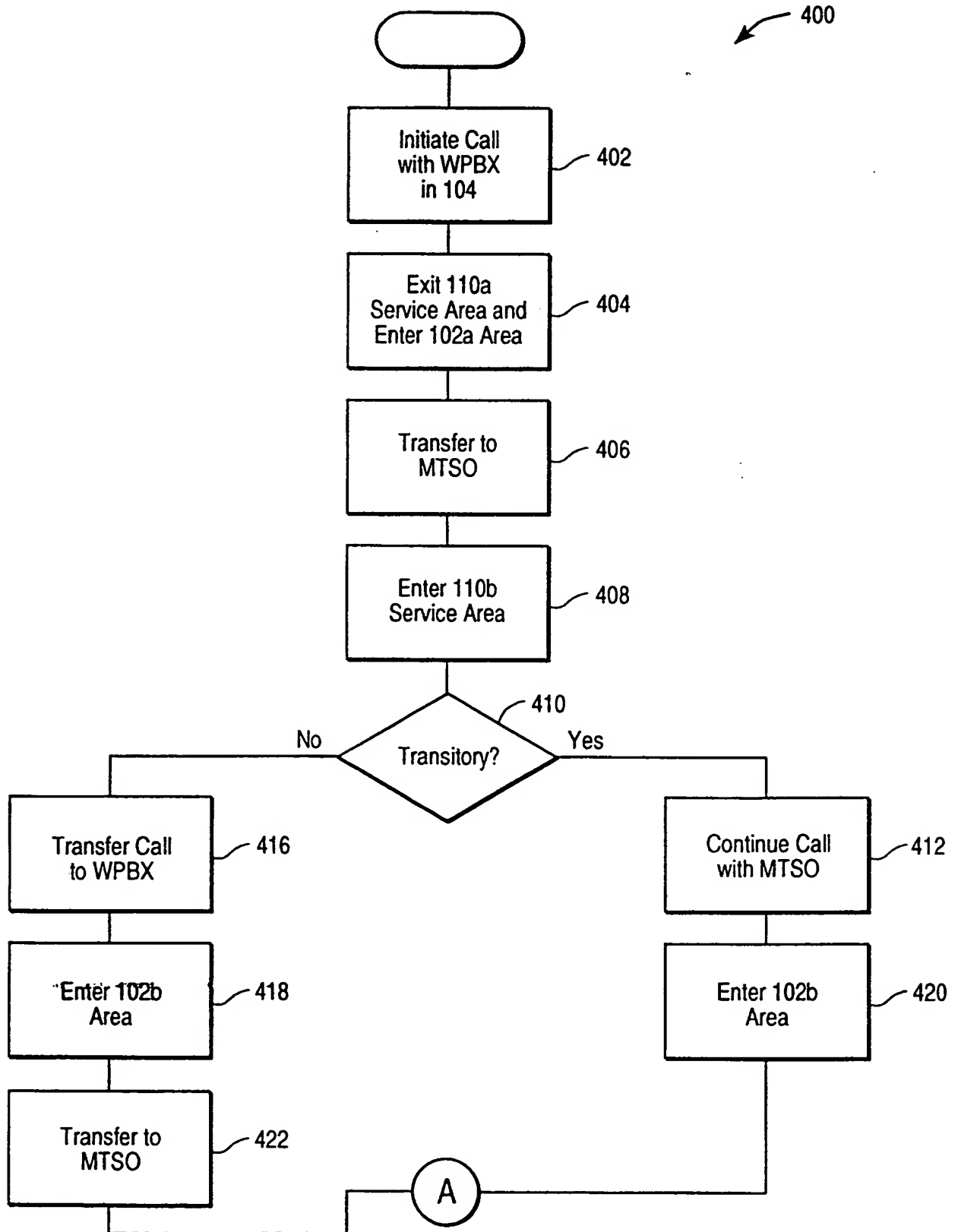
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**FIG 5**

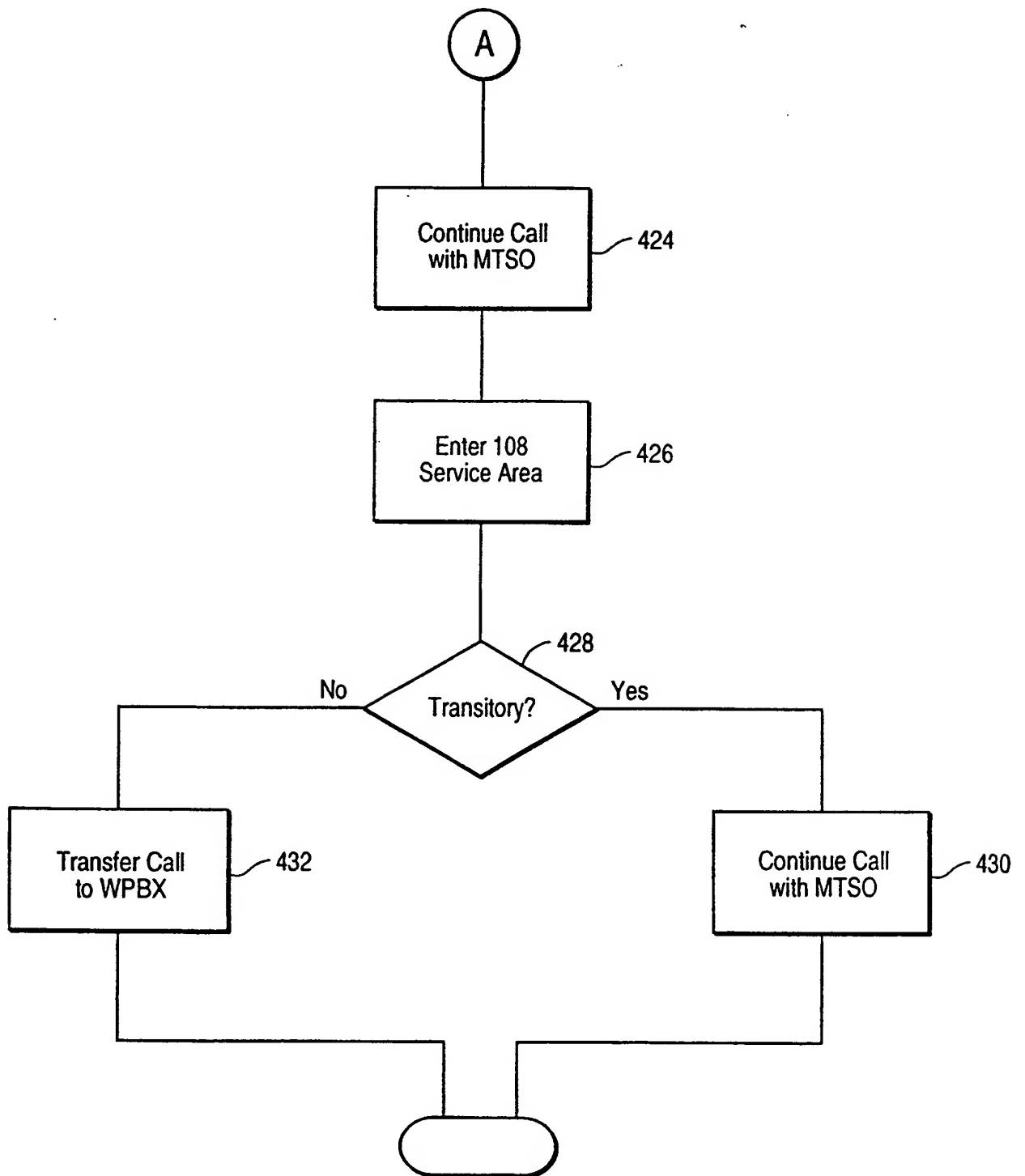
6 / 8

**FIG. 6**

7/8

**FIG 7A**

8 / 8

**FIG. 7B**

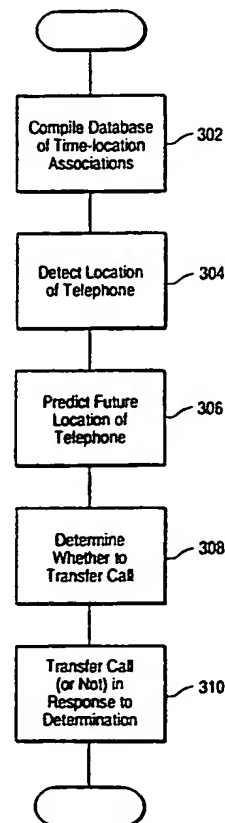


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/US97/23440 <b>(22) International Filing Date:</b> 17 December 1997 (17.12.97)  <b>(30) Priority Data:</b> 08/778,525                      3 January 1997 (03.01.97)                      US  <b>(71) Applicant:</b> SIEMENS BUSINESS COMMUNICATION SYSTEMS, INC. [US/US]; 4900 Old Ironside Drive, Santa Clara, CA 95052 (US).  <b>(72) Inventors:</b> SHAFFER, Shmuel; 1211 Cowper Street, Palo Alto, CA 94301 (US). BEYDA, William, Joseph; 21580 Edward Way, Cupertino, CA 95014 (US).  <b>(74) Agents:</b> VANCE, Heather, S. et al.; Siemens Corporation, Intellectual Property Dept., 186 Wood Avenue South, Iselin, NJ 08830 (US).		<b>(81) Designated States:</b> BR, CN, JP, KR, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>  <b>(88) Date of publication of the international search report:</b> 5 November 1998 (05.11.98)

**(54) Title:** SYSTEM AND METHOD FOR CELLULAR SMART SWITCHING**(57) Abstract**

A user's access patterns are accounted for in deciding to switch between a plurality of wireless networks (204, 206). A method according to one embodiment of the present invention includes monitoring a location of a wireless communication device (202) within a region serviced by a first wireless communication network (204) and second region serviced by a second wireless communication network (204). The first and second regions have an overlapping region which could be serviced by both networks. The future location of the wireless communication device (202) within the first and second regions is predicted based on the monitoring of the previous locations of the wireless communication device (202). When the wireless communication device (202) is detected as being within the overlapping region, the system determines whether to transfer an active connection between the wireless communication device (202) and one of the networks to the other network. In one embodiment, past patterns of usage of the wireless communication (202) device within the first and second region are identified and used to predict a future location based on the past pattern. In another embodiment, a calender of predetermined time-location associations is input into a controller (203) associated with the wireless communication device (202) and the prediction is based on an actual location and current time being compared with the values input into the calender.



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Inter. onal Application No

PCT/US 97/23440

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 H04Q7/38

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 96 13951 A (ERICSSON TELEFON AB L M) 9 May 1996 see abstract; figure 4 see page 4, line 5 - page 5, line 2 see page 11, line 13 - page 12, line 10 see page 19, line 14 - page 20, line 4 see page 29, line 3 - line 10 ---	1,2,6, 10-12
A	WO 92 02105 A (BRITISH TELECOMM) 6 February 1992 see page 8, line 6 - page 9, line 29 --- -/--	1-3,6, 10-12



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A	<p>LIU G Y ET AL: "EFFICIENT MOBILITY MANAGEMENT SUPPORT FOR WIRELESS DATA SERVICES" PROCEEDINGS OF THE VEHICULAR TECHNOLOGY CONFERENCE, CHICAGO, JULY 25 - 28, 1995, vol. 2, no. CONF. 45, 25 July 1995, pages 902-906, XP000551665 INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS see page 904, column 2, line 28 - line 34 ---</p>	7,8
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Information on patent family members

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